THE SALT CONTENT OF NATURAL WATERS IN RELATION TO RHEOTAXIS IN ASELLUS.[1]

W. C. ALLEE,

LAKE FOREST COLLEGE.

Much of my work on rheotaxis of the isopod *Asellus communis* Say has been based on the fact that pond and stream mores of the same species give different rheotactic reactions. Among other differences the pond mores have a low, and the stream mores, a high degree of positiveness ('12). I have wished for some time to determine whether there were differences in the salt content of the two classes of habitats that might account for the differences in behavior. Upon my return to the Chicago area after an absence of three years, I hastened to make this survey. The subject is the more interesting since experiments in the meantime have shown that the rheotactic reaction may be controlled by various salts when present in sufficient concentration.

Through the kindness of Mariner and Hoskins, to whom I was already indebted for similar analyses, the spring and autumn salt content was determined for County Line Creek, near Braeside, Ill., and for a point near Osborn, Indiana (Slough 93; Shelford, '13). Many of the isopods used in experimental work have been obtained from these habitats. The analyses are from approximately maximum-minimum water level for the year 1916 and are given in detail in Table I.

Of the elements found, calcium and magnesium are known to decrease the positiveness of rheotaxis in *Asellus* when present in sufficient concentration. If the salt content is at all responsible for the low positive rheotactic response of pond isopods, its effect should be most marked in the most concentrated water analyzed. This water contained 228.4 mg. of calcium per liter of water, the

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TABLE I.

SHOWING MAXIMUM-MINIMUM WATER LEVEL ANALYSES OF WATER FROM COUNTY LINE CREEK, BRAESIDE, ILL., AND SLOUGH 93, OSBORN, IND.

The solids are shown in parts per million by Mariner and Hoskin's analyses and the gases in c.c. per liter.

	Stream.		Pond.	
	Maximum.	Minimum.	Maximum.	Minimum.
Nitrogen as free ammonia	0.024	0.023	0.320	0.160
Nitrogen as albuminoid ammonia	0.150	0.098	0.160	0.288
Nitrogen as nitrates	None	0.700	0.840	0.800
Nitrogen as nitrites	0.0015	0.002	0.0012	None
Chlorine	5.000	12.000	72.000	277.000
Iron	0.200	1.400	0.500	1.400
Calcium	50.300	61.850	72.500	228.400
Magnesium	0.360	33.700	0.120	45.300
Sodium	45.2	8.0	45.200	116.700
Potassium	2.700	Trace	6.900	Trace
Free oxygen	6.8	3.0	5.1	1.6
Free carbon dioxide	3.2	2.5	8.6	11.7
Half bound carbon dioxide	79.5	82.6	113.4	119.6

equivalent of the amount of calcium contained in 0.011 normal solution of calcium chloride. Supposing for the moment this calcium were the only cation present in the water it would have no depressing action on rheotaxis.

Witness:

Isopod 146 gave a rheotactic reaction of 30 per cent. +, 50 per cent. −, 24 per cent. α when first tested and after being in 0.05 normal solution of calcium chloride for five days the rheotactic response was 90 per cent.+, 10 per cent. −.

Isopod 147 when first tested gave 60 per cent. +, 10 per cent. −, 30 per cent. α and after 48 hours in a similar solution of calcium chloride gave 40 per cent. +, 30 per cent. α, 30 per cent. 0.

Three other isopods (Nos. 175, 176, 177) after 10 days in the same strength calcium chloride solution gave an average response of 37 per cent. +, 30 per cent. α, 33 per cent. 0 while the average rheotactic reaction of 253 untreated isopods from similar environmental conditions was 31 per cent. +, 45 per cent. −, 22 per cent. α, 2 per cent. 0.

But calcium is not the only cation present. Magnesium, a less powerful isopod depressant than calcium, is found to the extent of 0.0037 normal solution. If at this strength magnesium

retains its depressing power, which laboratory tests similar to those just cited renders improbable, its action would be offset by the sodium which has an antagonistic effect and which is present in sufficient quantity to neutralize any possible depressing action of the nagnesium and to antagonize partially the action of the calcium, if that were needed.

Theoretically then, from the analyses of salt content, one would not expect the pond water to be less favorable for positive rheotactic reaction than the water from the stream; and this expectation was verified by laboratory tests. Stream isopods were kept in the laboratory for three days in water brought from their stream habitat. Then they were divided and part were put into pond water from the Osborn, Indiana, pond. Both lots of isopods were kept under identical conditions of temperature, aeration, and food supply for twenty days, during which time the eighteen tests shown in Fig. 1 were made. The graphs there show the percentage of positive reactions given daily by groups of five isopods chosen at random from the stocks under observation. The variation in positiveness is due in part to this chance selection of individuals for the daily tests ('13*a*) and in part to the setting in of an abnormal breeding season, brought on by the transfer from freezing stream water to a laboratory of about 15 degrees centigrade. The decline of positiveness is the usual effect of the breeding season.

For the eighteen days when comparative tests were made the stream isopods in pond water averaged 73 per cent. positive while their mates in stream water were 70 per cent. positive. This means that the difference in salt content of the two waters did not affect rheotaxis.

The most obvious difference in the two environments is the difference in the oxygen and carbon dioxide tension in the water. In the more extended work of five years ago, the oxygen tension of County Line Creek was found to lie normally between 5 and 10 c.c. per liter and the carbon dioxide tension was about 2 c.c. per liter. In the ponds the oxygen was usually under 3 c.c. per liter and the free carbon dioxide usually over 10 c.c. per liter. The amount of half bound carbon dioxide is also consistently greater in the pond than in the stream.

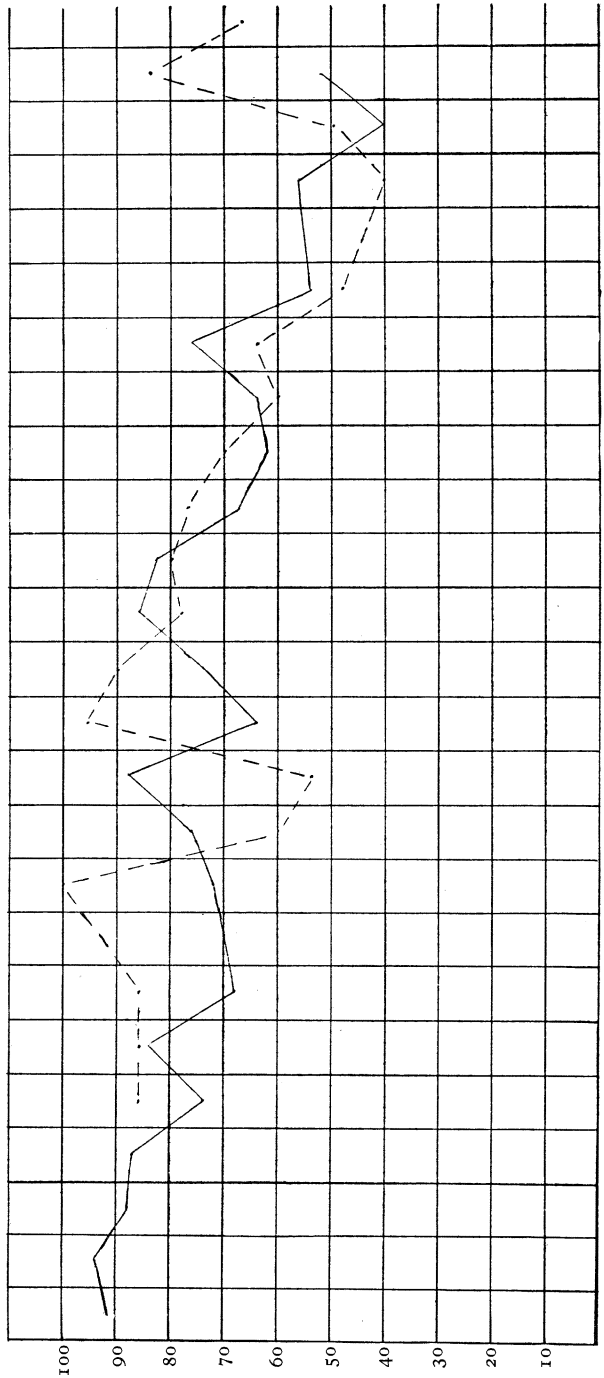

FIG. 1. Showing the result of rheotactic tests of stream isopods kept in the laboratory in stream water (solid line) and in pond water (broken line). As far as known the kind of water was the only factor varied. The abscissæ give the positive rheotactic reaction in percentage of the total trials for the day. Each space in the ordinates represents one day.

The rheotactic reaction of *Asellus* can be experimentally controlled by varying the oxygen and carbon dioxide tension within the limits found in the two classes of habitats. This is not true of similar variation in salt content, or in any other factor or group of factors yet studied.

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